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AUTHOR Thomas, David B.; Bozeman, William C.
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ABSTRACT

The availability of compact, low-cost computer systems provides a means of assisting classroom teachers in the performance of their duties. Computer-assisted instruction (CAI) and computer-managed instruction (CMI) are two applications of computer technology with which school administrators should become familiar. CAI is a teaching medium in which students respond to computer displays. The ability of computers to interact with students distinguishes CAI from most instructional media. The computer may provide corrective feedback or present new information based on the student's response. The forms of interactive CAI include drill, practice, tutorial programs, problem-solving, instructional simulation, and testing. CMI provides information to the teacher that assists in the management of learning activities, and facilitates the processing of student information. CMI systems alleviate the burdens of recordkeeping and thereby enhance decision-making. School administrators should provide the appropriate leadership and support for the use of CAI and CMI in the educational process. (JEH)

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COMPUTERS FOR YOUR CLASSROOM: CAI AND CMI

David B. Thomas and William C. Bozeman, The University of Iowa

The advent of low-cost and accessible electronic data-processing technology has raised a host of issues and concerns for those persons charged with policy and decision making in our schools. Only a few years ago the implications of computer technology were relevant only to administrators, teachers, and school board members in districts which could afford the large computing systems of the 1960s. Now, by contrast, computing capabilities are within reach of even the smallest district by using minicomputers and microcomputers, or by using the abundant resources obtainable through networks, consortia, and area educational agencies.

To gain a clearer perspective as to how dramatic this revolution in computing has actually been, consider the computer of the early 1950s. These first-generation computers were characterized by enormous size, considerable power consumption, thousands of vacuum tubes and relays, and literally miles of wire. The costs associated with these machines made them available only to a few large educational organizations.

Second-generation computers, using transistors rather than vacuum tubes, appeared commercially in the late 1950s. Although these computers were faster, less expensive, and more reliable, computing was still restricted to a small segment of our society.

Miniaturization of electronic components progressed at an unprecedented rate through the 1960s and 1970s with such breakthroughs as integrated circuits, large-scale integration, and microprocessor "chips." Now it is possible for the consumer to purchase a complete computer system which can nearly equal the capabilities of the large systems of the 1960s for less than $1,000. These "personal computers" are already having a dramatic effect on instruction at all levels of the educational sphere. Many persons speculate that in a few years the personal computer will be as commonplace as the hand-held calculator is today.

Given this availability of computing power in our society, it is important to understand how this technology can be employed in the educational arena. Administrative applications of electronic data processing can be traced back a number of years (e.g., student scheduling, transportation, reporting, and accounting). However, *widespread* instructional applications of computing are evident only during the last half of this decade. For this reason, it is important that persons charged with educational policy and decision making be knowledgeable about the instructional applications of the computer. Two common educational applications are computer-assisted instruction and computer-managed instruction. Understanding of these two applications is crucial as we approach the next decade.

In a typical classroom, teachers have four primary instructional duties. These include (1) providing information to the student about the subject matter of interest, (2) performing various activities which attempt to stimulate the learning processes of the student, (3) maintaining records of the student's progress through the subject matter, and (4) planning and scheduling learning activities appropriate for the student.

Over the past decade, computer technology has provided a means of assisting the classroom teacher in the performance of his/her duties. Teachers have had more time for working with individual students and for creating instructional materials. Computer-*assisted* instruction (CAI) and computer-*managed* instruction (CMI) are two applications of computer technology with which the school administrator should become familiar.

CAI is a teaching medium (television, film, and audiotape are other media) in which a student responds to displays of various kinds presented on a computer terminal (television screen or typewriter-like device which connects to the computer). The computer may provide new information, including corrective feedback if necessary, and the computer then may move on to additional information based on the student's response (Thomas 1979). In contrast to most media, CAI is known for its ability to respond to each student according to his/her individual answers. CAI programs are seen in many forms. Some of them are given below.

Drill represents a form of interactive CAI in which the student responds in a rather quick fashion to brief items or questions under a sort of "flash-card" format. The computer provides feedback as to the correctness of the student's answer and may adapt to the individual student by varying the number of items or the frequency of the stimuli based on the student's responses. Various algorithms may be employed to present missed items or item types over and over until mastery is attained.

Practice is similar to drill in many ways. This variety of CAI requires the student to perform more complex activities, perhaps calculations on a scratch pad or reference to a notebook. Under this form, the computer waits while the student "practices" the activity, then when the student provides an answer, provides corrective feedback and a new exercise.

Both the drill and practice varieties of CAI programs are integrated into curricula where teacher-supplied direction and auxiliary materials must dominate. These computer-based activities augment the teacher's activities.

Tutorial programs present information in paragraph form, interspersed with questions or fill-ins. The material adapts to each student by presenting different text based upon student responses or requests. Thus, if the tutorial is concerned with the distinctions between deciduous and coniferous trees, a short paragraph describing the characteristics of each might be presented. The student could then be asked to identify which type

of tree had leaves which fell annually. If the question were answered correctly, the student would then be presented with new information. If incorrectly answered, the question would normally be followed by a further explanation of the difference between the two tree types with emphasis on the annual shedding of leaves by deciduous trees. Graphic images might be employed for some students to further illustrate the differences. Much textual material is typically employed within this variety of CAI. The term "computer-assisted instruction" and "tutorial CAI" are often incorrectly used interchangeably. As previously described, CAI is considered the inclusive term: tutorial programs are one widely used form of CAI, but one which is specific as to its form. Drill programs, also CAI, represent yet another form of this medium.

Problem-solving programs typically help the student in the learning of principles or rules by harnessing the power of the computer to perform complex calculations. These programs are usually short procedures for which the student repeatedly supplies data to be manipulated according to the rule or principle being taught. Often, these CAI programs may be assigned by the teacher as a means to provide individualized illustration of principles. One example of such use may be an Ohm's law exercise whereby the student provides voltage and resistance values with the computer calculating and displaying the resultant amperage. Other examples might involve the computer's identification of prime numbers or the derivation of factors. The student in this case is expected to supply much of the intellectual "overhead" required for learning; the computer provides the calculation capability.

Instructional simulation programs model natural events in such a way as to add realism to the interaction with the student. Simulation permits the compression of time (as in an ecology demonstration where a number of years may be collapsed to a few minutes to show the effects of deforestation on growth of wildlife), avoids dangerous phenomena (as might occur with the manipulation of radioactive materials), and reduces the need for expensive equipment (equipment functions and readings may themselves be modeled). Simulations permit the student to experiment not only with physical/biological systems but also with social, economic, and behavioral systems. Thus the student could attempt to manage a simulated organization in an autocratic, democratic, or permissive fashion and receive feedback as to the probable effectiveness of each style. These interactions might take the form of situations to which the student must react with one of the three management styles. Subsequent situations are then derived from results of prior ones. Simulations can be powerful forms of instruction, transmitting the student beyond the classroom to realistic situations which may be manipulated at will.

Testing by computer permits the educator to exercise options not available with traditional testing methods. Items may be administered based upon prior responses to improve test reliability; alternate tests may be constructed for individualized programs; diagnostic tests may be collected into short testing sessions; tests may be scored at once; feedback of various forms may follow each item or may follow immediately at the conclusion of the test; item security may be enhanced by the absence of printed test sheets. Interest may be enhanced by interspersing test items with motivational devices at appropriate intervals.

These six forms of CAI support the classroom teacher's activities related to the provision of information and stimulation of the learning process. Computer-managed instruction, or CMI, supports the teacher and the instructional process in other ways.

Whereas the purpose of CAI relates to teaching, the purpose of a CMI system is to provide information to the teacher which assists in the management of learning activities. In this sense, the CMI system may be regarded as a management information system or instructional-decision support system. Stated another way, CMI seeks to facilitate the processing of information and to supply this information at appropriate times and places so that it can be applied directly to instructional decision making (Spuck, Bozeman, and Lawrence 1977).

Such a CMI system may prove to be quite valuable in programs of individualized instruction such as Individually Guided Education (IGE). In such programs, a teacher or groups of teachers may work with large groups, small groups, or individual students. Instructional strategies may rely extensively on preassessment test data, curriculum-imbedded test data, diagnostic tests, individual and group performance profiles, complex curricular structures with multiple learning paths, and prerequisite objective data (i.e., a knowledge of what skills must exist before progressing to new topics).

At least four primary elements can be identified within such an organizational/instructional program with respect to information management requirements: (1) individual student record maintenance; (2) assessment of individual learning and progress; (3) identification of instructional needs; (4) formulation of appropriate instructional groups.

Though the exact nature of certain programs of individualized instruction may vary, it is clear that the clerical and record-keeping tasks associated with such programs are quite burdensome. In fact, there is a growing body of evidence to support the fact that the success or failure of such a program may be attributable to the requisite record keeping which must be performed by the instructional staff (Spuck and Bozeman 1978).

CMI systems may not only alleviate much of this burdensome record keeping, but also may serve to enhance the quality of decision making. For example, the CMI system may make recommendations for instructional groups on the basis of the instructional needs previously identified. This is accomplished by searching a particular group of student records and indicating whether students are eligible for a given instructional objective, topic, or module, listing those who are, as well as a summary report listing all student eligibilities.

CMI systems may operate "interactively," that is, the instructor may enter requests, update records, and so on by way of a computer terminal or in a "batch mode" in which information is submitted on cards or scan sheets which are processed at a later time by clerical personnel. Regardless of the specific computer configuration, there are several benefits which can accrue from the utilization of a CMI system:

- Reduction of teacher time devoted to clerical and record-keeping tasks
- Enhanced record systems
- More effective and efficient use of planning time and decision making
- Improved diagnostic and prescriptive capabilities
- Student achievement profiling
- Curricular evaluation

Though there is considerable potential for the enhancement of the overall instructional program through the utilization of CMI, there is an important caveat which should accompany this discussion. CMI, regardless of the sophistication of the system, is not a substitute for decision making by the teacher. The system can only form logical conclusions based on given information related to the student, the curriculum, and certain decision-making rules or algorithms.

Although CMI appears to be a viable form of instructional management, the state of the art is yet too young to offer conclusive evidence related to effectiveness (Bozeman 1979). Several projects have offered proof of concept, but the absence of a longitudinal study prevents the type of conclusions which can be derived through a comprehensive evaluation related to CMI utilization and effect.

Computer usage in the classroom may take forms other than the two mentioned above. Computer literacy instruction can use the computer as illustration of the concepts taught. Data analysis activities as part of an accounting or sociology class can be conducted through a classroom computer. Word processing might be used as an adjunct to a creative writing class or as an

integral part of a typing class. Of course, the computer can be used as a tool in a class on programming.

It is beyond the scope or purpose of this article to address how a school or district should determine its needs or requirements in the area of instructional computing. It is, however, strongly recommended by the authors that such applications not be undertaken casually. Failure to involve persons knowledgeable in both the areas of traditional instruction and computing with those who will be using this technology may result in considerable dissatisfaction, not to mention unnecessary or misplaced expenditure of limited funds.

Instructional computing can be a wonderful enhancement in the school. It is the responsibility of the wise and prudent administrator to provide the appropriate leadership and support for this aspect of the learning enterprise.

Computer-assisted instruction and computer-managed instruction are merely the beginnings of computer usage in the classroom. The mere presence of a terminal or microcomputer will motivate many students to explore computing further—to investigate hardware, to experiment with computer languages, to explore computer art or computer music. Information networks will permit the enterprising student and creative teacher to investigate new areas such as current events, financial markets, or worldwide electronic mail. Brighter students and their teachers may explore ideas with seasoned researchers worldwide. The implications are broad, nearly limitless.

As more and more microcomputers enter the home, the amusement park, the public library, and the town arcade, educators should be ready to meet the challenge of these alternatives to traditional classroom knowledge dissemination. CAI and CMI have much to offer the educator in this regard, but the creative classroom teacher and school administrator must extend these instructional forms and demonstrate the computing techniques which the students of the 1980s will require to enrich their lives in the 1990s and into the next century.

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Dr. Thomas is associate research scientist in the CAI Laboratory and Instructional Services division of the Weeg Computing Center at The University of Iowa, where he consults with faculty and staff on instructional computing. His areas of particular interest and expertise are instructional uses of microcomputers, instructional evaluation, and computer-based testing.

Dr. Bozeman is an associate professor of educational administration at The University of Iowa, where he teaches courses related to computer applications in education, systems analysis, and systems planning and design. He is also actively involved in several projects and organizations related to these areas.

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William C. Bozeman, Editor
The Executive Review
Institute for School Executives
210 Lindquist Center
The University of Iowa
Iowa City, Iowa 52242